# Drones guide smarter nitrogen use in tobacco fields

GA, UNITED STATES, March 19, 2026 /EINPresswire.com/ -- Balancing nitrogen use is critical for maximizing crop yield while minimizing environmental and economic costs. A new approach integrates drone-based multispectral imaging with machine learning to guide nitrogen application in tobacco fields. By combining multiple crop growth indicators into a single decision index, the method

Experimental flow chart.

enables more precise fertilizer recommendations, reducing nitrogen inputs while increasing yield, improving field uniformity, and enhancing overall economic returns.
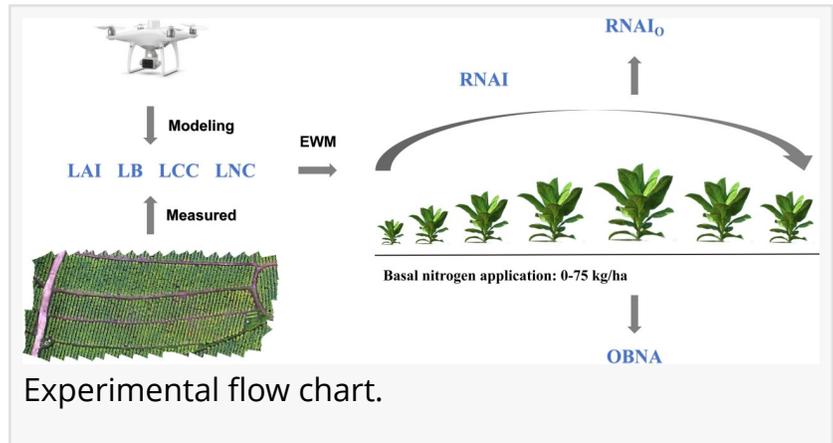
Nitrogen plays a central role in crop growth, directly influencing leaf development, photosynthesis, and final yield. In practice, however, nitrogen fertilizer is often applied based on experience rather than quantitative assessment, leading to overuse, resource waste, and environmental pollution, or underuse that limits productivity. Remote sensing technologies—especially unmanned aerial vehicle (UAV)-based multispectral imaging—offer new opportunities to monitor crop status dynamically and non-destructively. Yet many existing approaches rely on single indicators, such as leaf nitrogen content, which fail to capture the complex interaction between plant structure and physiology. Based on these challenges, there is a strong need to develop an integrated, data-driven framework to support precise nitrogen decision-making in crop production.

In a study published in Journal of Remote Sensing on January 15, 2026, researchers from agricultural and information technology institutes in China introduced a nitrogen application decision-making scheme based on UAV multispectral imagery. The research addresses a long-standing challenge in tobacco cultivation: how to match nitrogen supply with crop demand across heterogeneous fields. By linking aerial spectral data with machine learning models, the team developed a practical system capable of translating crop growth signals into actionable fertilizer recommendations, supporting precision agriculture under real field conditions.

The study proposes a Recommended Nitrogen Application Index (RNAI) that integrates four key

agronomic traits: leaf area index, leaf biomass, chlorophyll content, and leaf nitrogen content. Rather than treating these indicators equally, the researchers applied an entropy weight method to objectively determine their relative importance. UAV-derived vegetation indices were then used to estimate each trait through machine learning, with extreme gradient boosting models consistently outperforming traditional random forest approaches. The resulting decision model translated RNAI values into spatial nitrogen application maps. Field application of this strategy reduced nitrogen fertilizer use by 7.4%, increased tobacco yield by over 2%, and significantly improved yield uniformity across fields.

Field experiments were conducted over two growing seasons using seven nitrogen application levels. Multispectral images captured by UAVs were synchronized with ground measurements of crop traits at key growth stages. From the imagery, 30 vegetation indices were extracted and screened using correlation analysis and recursive feature elimination to identify the most sensitive spectral features. Machine learning models were trained to estimate agronomic traits, achieving coefficients of determination above 0.87 in test datasets and strong cross-year stability.

Using these estimates, RNAI values were calculated and fitted against nitrogen application rates to identify optimal nitrogen levels. The resulting model generated prescription maps guiding topdressing fertilization at the field scale. When implemented in regional tobacco fields, the approach reduced pure nitrogen use by 3.71 kg per hectare while increasing yield by 54.56 kg per hectare. Economic analysis showed a 2.58% increase in net returns, alongside improved spatial consistency in crop performance.

The research team noted that integrating structural and physiological crop traits provides a more realistic assessment of nitrogen demand than single indicators. They emphasized that UAV-based decision maps can help farmers move from uniform fertilization toward adaptive management, improving efficiency while reducing environmental risks. The authors also highlighted the robustness of the approach across seasons, suggesting strong potential for operational deployment.

The study combined UAV multispectral imaging, field sampling, and machine learning. Multispectral data were collected under controlled flight conditions and processed to extract vegetation indices. Ground measurements of crop traits were used for model training and validation. The entropy weight method quantified indicator importance, while random forest and extreme gradient boosting algorithms were applied for trait estimation. Model performance was evaluated using statistical accuracy metrics and cross-year validation.

Beyond tobacco, the proposed framework offers broad potential for other crops requiring precise nitrogen management. With recalibration for local varieties and climates, the method could support sustainable fertilization strategies at regional and national scales. By reducing nitrogen overuse, the approach also contributes to environmental protection and soil health. As UAV technology becomes more accessible, such data-driven decision systems are likely to play

an increasingly important role in the future of precision agriculture.

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